Exploring low carbon futures.

Mélodie Cartel, Franck Aggeri

CAHIERS DE RECHERCHE DU CGS - CGS WORKING PAPERS SERIES

Exploring low carbon futures,
Experimental carbon markets as mediating instruments

Mélodie Cartel
Centre de Gestion Scientifique (CGS), MINES ParisTech
melodie.cartel@mines-paristech.fr

Franck Aggeri
Centre de Gestion Scientifique (CGS), MINES ParisTech franck.aggeri@mines-paristech.fr

Working Paper 2013-02

CENTRE DE GESTION SCIENTIFIQUE
MINES PARISTECH
60 Boulevard Saint-Michel
75272 Paris cedex 06 France
http://www.cgs.mines-paristech.fr

CAHIERS DE RECHERCHE DU CGS

Cette collection a pour but de rendre aisément disponible un ensemble de documents de travail et autres matériaux de discussion issus des recherches menées au CGS (Centre de Gestion Scientifique).

Des versions ultérieures des papiers diffusés dans cette collection sont susceptibles de faire l'objet d'une publication. Veuillez consulter la base bibliographique des travaux du CGS pour obtenir la référence exacte d'une éventuelle version publiée.

CGS WORKING PAPERS SERIES

The aim of this collection is to make easily available a set of working papers and other materials for discussion produced at the CGS (Centre de Gestion Scientifique).

Further versions of these working papers may have been submitted for publication. Please check the bibliographic database of the CGS to obtain exact references of possible published versions.

CENTRE DE GESTION SCIENTIFIQUE
MINES PARISTECH
60 Boulevard Saint-Michel
75272 Paris cedex 06 France
http://www.cgs.mines-paristech.f

Exploring low carbon futures,

Experimental carbon markets as mediating instruments

Mélodie CARTEL

Centre de Gestion Scientifique de MinesParis-Tech, France

Franck AGGERI

Centre de Gestion Scientifique de MinesParis-Tech, France

Abstract

The collective production of future-oriented images is a significant activity that enables the design of long-term strategies for climate mitigation. In Europe, the image provided by the Kyoto target induced a particular anticipatory action that consisted in performing carbon markets to provide a framework for climate mitigation. Building on original empirical material (the GETS experiment), we discuss the strategic dimension of performativity as anticipatory action. We argue that the specific activities that supported the performation of theoretical carbon markets were closely related with how strategic actors envisioned the future. The GETS (Greenhouse gas and Electricity Trading Simulation) is an initiative undertaken by the European electricity sector that played an important role in the construction of the EU-ETS. Surprisingly, it is missing from the records. From a theoretical perspective, the paper highlights the role of mediating instruments in enabling the joint process of performing carbon markets and unfolding a low carbon future.

Key words

Climate change, mediating instruments, future-oriented images, performativity

Introduction

This paper explores how the private sector engages in strategic anticipatory action in the context of climate change. How do companies develop intervention capacities and patterns to act upon a future that is both indeterminate and threatening? How can anticipatory strategies be devised when information on both future conditions and the regulatory framework is limited, diffuse, and often contradictory (Godard, 2004)? In a soft regulatory context, companies facing shared uncertainties must create the conditions needed for the future to become manageable (Aggeri, 1999). The question of how indeterminate futures are acted upon is not new and has materialised in various forms within organisations (Anderson, 2010). In this paper we more specifically examine the performation of carbon markets in Europe as anticipatory action and how it relates to the way the power sector frames the issue of climate change.

Climate change provides good empirical insight to explore how the future is being related to contemporary anticipatory action, as in this context "acting in advance of the future is an integral, yet taken for granted, part of liberal-democratic life" (Anderson, 2010). The imminent threat of dangerous climate change (Liverman, 2009) justifies a wide range of anticipatory action. One such type of action consists in promoting an alternative future that is commonly referred to as a *low-carbon future* (Nerlich, 2012) through mitigation strategies. The adoption in 2003 of the EU-ETS[1] was the first step towards a *low-carbon future* in Europe. In response to

[1]European Emission Trading Scheme

the Kyoto protocol, the European Commission set out the performation of carbon markets as a cornerstone of its mitigation strategy.

To be acted upon, an indeterminate, ambiguous and uncertain future must somehow be known. The production of stable and certain images of the future is a strategic activity within our modern societies that seeks to inform our choices in the present and to drive long-term social and technical changes (Borup and al, 2006). By reducing its complexity and bringing clarity and, to some extent, certainty into what the future might hold, they open and support new capabilities for action. Drawing on the case of the EU-ETS, this paper explores how the performation of economics (Callon, 1998; MacKenzie, 2004; Muniesa and Callon, 2007) is being related to the future through the production of future-oriented images. We adopt a mediating instruments approach (Miller and O'Leary, 2007) to investigate how concrete tools, instruments and devices supported both the exploration of the future and the performation of carbon markets. This paper intends to provide insights on how both the future-oriented images of a *low-carbon future* and carbon markets were reflexively engineered and reshaped, following a complex design process.

There is an official story of the construction of the EU-ETS. Drawing on thirty years of economic theory, the European Commission implemented the world's first carbon market in the world (see e.g. Convery, 2009; Damro and Luaces-Mendes, 2003; Ellerman and al, 2010). One part of the story that was left out is the huge collective inquiry that supported the performation of carbon markets (Braun, 2009). Building on Callon's view of carbon markets (2009) as on-going collective experiments, we re-analyse the construction of carbon markets

by looking at one of the experiments that had a huge impact on the performation of the EU-ETS. From 1999 to 2001 the European power sector engaged in the simulation of a *low-carbon future* through role play using an experimental carbon market device named GETS. This experiment had a considerable impact on the framing of the issue of climate change in Europe. Yet, interestingly enough, there are no traces of this experiment in the abundant literature on the implementation of the EU-ETS. Using this enigma as our starting point, we carried out empirical research on the GETS experiment, how it was conducted, the tools and models on which it was based, and the kind of knowledge about low-carbon futures that it performed.

The paper is organised as follows. We first explore the notion of future-oriented images and how they support action; in particular how they induced the performation of carbon markets in Europe. Second, we review the research programme on the performativity of economics. The question of how strategic performation activities are being used to address the future has not yet been investigated. Drawing on the largely unknown GETS case, we use a mediating instruments approach to provide another narrative of the construction of the carbon market in Europe. In this alternative story, the paths leading to a low-carbon future are multiple and uncertain, based on a distributed engineering process in which tools (simulations, calculation devices) play a key role in the collective making of low-carbon futures. Finally, we investigate the extent to which the GETS impacted the way that the response to climate change is being framed at different levels.

Building on images to act upon the future

Producing future-oriented images, a strategic activity

On the diversity of future-oriented images. Over the last two decades, the significant growth of climate change as a topic of political debate has generated abundant future-oriented images: the Kyoto targets, the UNEP maps coloured in red and orange to stress the vulnerability of populations to future climate change (Nellemann and al, 2011), the IEA technology roadmaps setting the milestones for the transition to low-carbon technologies, the IPCC charts showing surface warming projections (IPCC, 2007), etc. The nature of these images, their origin, how they circulate and the actions they induce are particularly heterogeneous, given the wide range of actors involved in their production, the specific interests they defend, and the methods they use to produce them. In this paper we focus on the images that are produced through a conscious and organised epistemic operation. Anderson (2010) distinguishes three ways of producing future-oriented images: scientific methods (e.g. modeling), performance (e.g. role-plays) and imagination exercises (e.g. backcasting). We especially look at the experimental exercises that are undertaken by organizational actors to learn about the future.

On the nature of future-oriented images (FOI). For heuristic purposes, we distinguish five constituent tensions within these FOI: (1) they exist and circulate through materialities such as reports and maps (Anderson, 2010; Liverman, 2009) or immaterialities such as discourses, narratives and lexical "carbon compounds" such as a *low-carbon future* (Hulme, 2008; Liverman, 2009; Nerlich, 2012); (2) they can be either individual or collective: in the case of climate change, there is an organization – the IPCC – in charge of making collective the images produced through scientific methods; (3) they can be concise or elaborate; for instance, the

same future climate state can be presented in a reduced format using numbers (Amoore, 2009), such as forecasts on temperature increases or detailed scenarios (Anderson, 2007 ; de Goede and Randalls, 2009); (4) they can be positive – utopias – or negative – dystopias (Hjerpe and Linnér, 2009; Van Aalst MK, 2006); and (5) they can be predictive and show what might happen, e.g. the IPCC reports, or normative and show a more desirable future, e.g. the Kyoto targets. By definition, FOI capture only certain aspects of the future, as every attempt to depict the future requires the selection of information from an abundance of data to provide a simplified representation (Segrestin, 2006). They are not mutually exclusive: one same state of the future climate can be described using different images that are not necessarily coherent with one another.

Driving change through future-oriented images

Future-oriented images are artificial representations of the future that make it actionable (de Goede and Randalls, 2009; Liverman, 2009; Pinder, 2005). Their role in relating contemporary action to the future has inspired a considerable amount of academic work in social studies. For example, with regard to technological innovation, a wide range of scholars from the fields of economic history, innovation studies and the sociology of technology and science have been exploring the role of "expectations" in driving social, economic, scientific and technological change (Borup and al, 2006; Brown and al, 2000; Eames, 2006; Guice, 1999; Michael, 2000; Van Lente, 1993). The literature on risk management offers insight into how the construction

of risks induces prevention, pre-emption, preparedness and other forms of anticipatory action (Nyberg and Wright, 2011).

Performing Carbon Markets in Europe: A "textbook case"

The construction of the European carbon market is a "textbook case" of how future-oriented images induce action in the present. From 1992 the international community was mobilised around images produced by the IPCC, to collectively negotiate an alternative future which was to be institutionalised in 1997 in the Kyoto Protocol. The desirable future was then represented by a single new image, in the form of figures: the greenhouse gas reduction objectives to be imposed on the so-called Annex 1 countries. In Europe, this image has been built around a particular action logic: the performation of economic theory. The story of the construction of the European carbon market as influenced by economic thought and concepts is well known and has been documented by many scholars, in particular by the economists who were at the helm of that very construction: among others, Peter Vis and Peter Zapfel, two civil servants in charge of the dossier at the European Commission; Jos Delbeke who was supervising the team at the European Commission; Frank Convery, who had been involved in the negotiations as an observer, and Denny Ellerman, an expert on the US SO_2 markets. The official story of the European Emission Trading Scheme (EU-ETS) is often defined by two critical moments.

Theory Building. The idea of using a market to manage industrial emissions can be traced back to Ronald Coase (1960) and his seminal article, *The Problem of Social Cost*. Crocker (1966), Dales (1968) and Montgomery (1972) further developed Coase's theoretical framework to apply it to environmental issues (Tietenberg, 2006; Convery, 2009; Ellerman, Convery and de Perthuis, 2010; Ellerman, 2003). In 1995, the US Environmental Protection Agency (EPA) launched the first 'cap-and-trade' market covering SO_2 emissions at national level, which is often considered to be the direct ancestor of the EU-ETS (Ellerman, Convery and de Perthuis, 2010; Damro and Luaces-Mendez, 2003).

Performing theoretical carbon markets. Responding to the impulse of the Kyoto protocol (Convery, 2009; Skjaerseth and Wettestad, 2008; Zapfel and Vaino, 2002) and following its failure to implement a carbon and energy tax at the domestic level (Braun, 2009; Newell and Paterson, 1998; Wetestad, 2005), the European Commission organised the construction of a regional emission trading scheme. The European Commission´s climate change team then succeeded in securing consensus among the main stakeholders during a stormy consultation process (Christiansen and Wettestad, 2003; Convery, 2009; Hepburn and al, 2006; Zapfel and Vainio, 2002).

What the story tells us. This narrative tells us about the performation of theoretical carbon markets as a response to the European Kyoto target. Given the underlying tensions identified by Muniesa and Callon (2008), we can qualify the act of performation carried out by the

Commission as: (1) planned – the action was not spontaneous, it was organised by the European Commission; and (2) restricted – in so far as it flowed from a scientific core of economics "outwards", towards the world of economic experts in charge of devising a market device based on economic theory.

What the story does not tell us. In the official story of the EU-ETS, the performative nature of carbon markets is taken for granted. There is no mention of the invisible “performative work” carried out by strategic actors to create the socio-technical conditions for carbon markets to materialise. To paraphrase Callon (2009), the making of carbon markets is an ongoing collective experiment. A variety of actors conducted continuous, original experiments in laboratories, *in vivo* (real scale experiments), or by way of experimental platforms (Muniesa and Callon, 2007) that participated in the material construction of carbon markets and the goods exchanged on them (Braun, 2009; Lohman, 2009; MacKenzie, 2009). Amongst these actors, with their different interests, projects, objectives and knowledge, were those that Callon (2009) calls the "usual suspects", that is, those who are legitimate and clearly visible in the construction of European environmental directives, such as officials from the European Commission DG XI, and stakeholders officially mobilised in the regulation process (NGOs, experts, representatives of industry, etc.), as well as various actors who initially had no say in the matter.

One of the unacknowledged experiments that was undertaken before the EU-ETS was established was led by the European power sector. It is called the GETS (Greenhouse Emission

Trading Scheme). Strangely enough, even though this experiment is sometimes recognised as a pioneering experiment among certain experts in the domain, it is hardly mentioned in the literature about the history of the EU-ETS[2]. There are nevertheless two clues indicating the importance of this experiment in the construction of a European carbon market: the rules underpinning the design of GETS2, and those of the EU-ETS pilot directive are almost identical despite the fact that there were many other possible designs proposed (see Table 1). The network of experts who were involved in the GETS experiment gradually expanded to include experts who were then directly involved in the design of the EU-ETS.

----------Insert Table 1 about here----------

These two clues attracted our attention. If this experiment played an important role in the making of the EU-ETS, why is it not mentioned in the literature? If its significance can be verified, what kind of knowledge about the future did this experiment actually perform?

The fact of considering a detail as significant or insignificant is not an empirical question. On the contrary, it is a theoretical one. As certain work in the pragmatic philosophy literature reminds us (Latour, 1987), we may well wonder whether it is not the intellectual construction underpinning theoretical accounts that causes all those elements that do not fit with it to be eliminated. In the official history of the construction of carbon markets written by economists, experiments play a secondary role. Theory prevails. But a whole other history of the

[2] For academic articles citing the GETS experiment, see Braun, 2009; Meckling, 2011.

construction of markets and associated futures is possible. It consists in considering the design of markets, following Callon, as a process of experimentation under uncertainty, based on the use of instruments and devices.

From a theoretical point of view, the GETS case study can evidence about the relationship between performation as an anticipatory strategy, and the production of future-oriented images.

Research design

Studying the performativity of economics

In recent years, a research programme specifically dedicated to the performativity of economics has been developed. This programme was launched in 1998 with Callon's book "The Laws of the Markets" to provide a new understanding of the relationship between economics – as a discipline – and the economy – as an activity. Since then, a wide range of literature has flourished, providing a stimulating view on the way markets are created and transformed (Muniesa and Callon, 2008). One particular branch of this programme – which MacKenzie (2007) labels generic – focuses on the activities that support performativity. Building the concrete conditions for a theoretical statement to become true involves a specific work. Callon recommends that special attention be given to the socio-technical agency that verifies a theoretical statement and its evolution. Following this recommendation, MacKenzie and Millo's seminal work (MacKenzie, 2003; 2004; 2006; MacKenzie and Millo, 2003) focuses

on the dynamic adjustments between the Black-Scholes equation and its socio-technical environment. The formula "did not simply describe a pre-existing world, but helped create a world of which the theory was a truer reflection" (MacKenzie, 2003: 835). The dynamic adjustment of both a theoretical statement and the world to which it relates is supported by experimental activities that enable the testing, amendment and remaking of the material conditions needed for the statement to fit its environment (Guala, 2005; 2007). From a managerial point of view, the question of how performative work is being related to the future offers stimulating perspectives as it re-repositions strategic actors, in particular firms, at the heart of the research inquiry.

An instrument-based approach to collective action

The GETS experiment relied on a set of tools and instruments that enabled the performation of carbon markets. Taking the detailed analysis of these instruments further, we built an analytical framework derived from a "mediating-instrument" (Miller and O'Leary, 2007) or "instrument-based approach" of collective action (Labatut and al., 2012), as it is referred to in the literature.

From management tools to mediating instruments. The theoretical approach underpinning mediating instruments can be traced back to the management studies of management tools in the 1970s in France and the UK. Management tools are the invisible technical infrastructure that supports organised action (Berry, 1983; Moisdon, 1997; 2005). They support intervention by increasing actors' rationality (Hatchuel and Weil, 1995). Drawing

on Aggeri and Labatut (2010) we use the word "tool" to denote basic support for intervention (e.g. indicators or scorecards). "Instruments" refer to a higher level of complexity. They involve a greater degree of reflexivity by designers and users than do tools (e.g. decision-making instruments, economic models). The word "device" refers to intricate combinations of agents, management tools and knowledge.

Mediating instrument and collective action. Miller and O'Leary (2007) use the notion of mediating instruments to refer to those instruments that provide strong coordination support for collective action. Building on the case of the microprocessor industry, they show that Moore's law brought together actors and domains and legitimised investment, in such a way that the making of future markets for microprocessors could continue. Mediating instruments frame collective representations and decisions so as to make the collective construction of a desirable future possible.

Collective learning and mediating instruments. We define learning as the process whereby actors share or generate knowledge collectively (Hatchuel, 1994). "*There are two ways one can learn from* [management tools]*: by crafting them and by using them*" (Morrison and Morgan, 1999). The construction of scientific knowledge and its regeneration depends on actors' reflexive ability to re-make their instruments and rethink the way they work (Hacking, 1993). Instruments are the prism through which the future becomes observable. Instrumentation is designed and regenerated throughout the exploration process to explore further and "learn what has to be learnt" (Hatchuel and al, 2005).

Research framework

In line with these theoretical groundings, we explore how performative work undertaken by strategic actors is being related to the future.

1. The performation of a theoretical statement within the present and the exploration of the future are two intertwined activities.
2. These two activities are undertaken jointly through the dynamic testing and revision of a mediating instrument (Miller and O´Leary, 2007).
3. The performation process is supported by experiments that take place within specific spaces that Muniesa and Callon (2007) call platforms. Platforms have received little attention in the literature; and in this paper we describe one of them.

Methodology

Field settings

In the late 1990s, the European electricity sector was faced with two major challenges: (1) the liberalisation of the electricity sector; and (2) the imminent threat of a carbon constraint following the Kyoto Protocol. Due to the high carbon content of traditional electricity production – that relied heavily on fossil fuels – a carbon constraint would potentially have huge impacts on industrial activity.

A first set of questions had to be dealt with regarding technology and R&D issues: would the sector have to deploy existing technologies? Would it have to design new technologies to deliver low-carbon electricity? Would it have to change its relations with consumers to

enhance end-user energy efficiency? Would its activity simply gradually disappear, to be replaced with decentralised private energy systems?

Another set of questions was more concerned with policy debates: how much time was left to organise the energy transition? What policies would the public authorities implement for this purpose?

Without reliable scientific knowledge on both the future conditions and the R&D effort that were needed to build a desirable future, actors in the electricity sector gathered to build shared knowledge and common frameworks for action. They designed an experimental carbon market device to simulate different *low carbon futures*. From 1999 to 2001, Eurelectric, the electricity company association in Europe, carried out a wide collective experiment on *carbon trading*.

Data collection

We conducted an in-depth longitudinal case study analysis covering a 5-year period from the "preparatory phase" of Kyoto in 1997 to the EU-ETS implementation in 2003 (Pettigrew, 1990). The data were collected over two and a half years of in-depth investigation, from December 2009 to June 2012.

Archival research. We collected both internal documents (personal mail archives, companies' internal reports, etc.) and external documents (Eurelectric's official position papers, GETS simulation reports, the written accounts of the European Commission's stakeholder meetings,

etc). These documents provided us with two types of information: (1) for the duration of the GETS experiments, we have access to the knowledge (on carbon markets and on the future) that was produced and to engineering activity that was undertaken on the device; (2) for the period after the GETS experiment, we have access to material on the collective negotiation of the design of the EU-ETS pilot. This historical approach seeks to trace the collective inquiry on both carbon markets and a carbon constrained future. It enables us to reconstruct the path that was followed by the actors, as a back and forth process between future-oriented images and experimental performation devices.

Interviews. We complemented the archival research with interviews with both the actors of the GETS and the main stakeholders of the collective inquiry on carbon markets: what were their strategic positions towards carbon markets and how did these positions evolve throughout the GETS experiments? What types of strategic alliances were created around the GETS performation device? We held 18 semi conducted interviews among these actors.

We distinguish with three types of actors playing different roles in the GETS experiment: (1) the organisers of the experiment (economists, physicists, lobbyists, consultants, etc.); (2) participants in the role play (mainly electricity companies, industrial companies and financial institutions); and (3) external contributors.

Among the organisers of the role play, we interviewed two members of Eurelectric: (1) John Scowcroft, Head of Eurelectric's working group on climate change, who, since he had been in charge of the dossier on the liberalisation of the electricity sector at UNIPEDE, had become "a

devoted supporter of market instruments" (Scowcroft, 2012); and (2) Jean-Yves Caneill, a member of the working group who had acquired special skills in modelling during his PhD. From the International Energy Agency, we interviewed Richard Baron, a young economist specialised in emission trading, who was in charge of supervising the GETS simulation. From ParisBourse stock market, we interviewed Thierry Carol, a young trader interested in the developments surrounding environmental markets.

Among the participants of the role play, we interviewed representatives of each sector involved – electricity, industry, financial –, in order to compare their strategic positions and expectations with regard to carbon markets and the evolution of these positions over the course of the experiments. We interviewed Jean-Yves Caneill again in his capacity as head of climate policy at Electricité de France[3]. From the industry, we met Chris Boyd, who was in charge of sustainability issues at Lafarge[4] and was in favour of market-based instruments, as well as two members of the paper industry. From the financial sector, we interviewed Dirk Forister from NatSource, an asset management services provider for environmental markets. He was in charge of defending the financial sector's participation in the EU-ETS as the sector's participation in a European carbon market was controversial. We weren't able to interview Peter Vis from the European Commission that contributed to the GETS experiment as an external advisor.

[3]Electricité de France is the French leader in the electricity sector
[4]Lafarge is the French leader in the cement sector

As regards the main stakeholders who were not directly involved in the experiments, we interviewed Peter Zapfel, a member of the team in charge of the Dossier at the European Commission, to understand the nature of the relations between the EC and the electricity sector. We also interviewed two carbon economists and one member of the French industrial think tank on sustainable development "Entreprises Pour l'Environnement" (EPE), who enriched our understanding of the events that led from Kyoto to the enactment of the EU-ETS.

Data analysis

Our aim was to identify the impacts of the experimental activities undertaken within the GETS experimental platform, on both the performation of carbon markets and the understanding of future conditions. We built a genealogy that shows the joint evolution of three dimensions:

- the design of the GETS device
- the knowledge generated by the device
- the relations among the actors (organisers, participants, external advisors, stakeholders)

Archival documents. We used the GETS reports to reconstruct the GETS device – rules, instruments, actors – its evolution and the knowledge it produced. We then identified two key steps in the making of the GETS device: first, a generic model of carbon markets was designed in 1999 and used to support a role-play; second, the GETS device was redesigned and supported another role-play.

Interviews. We used our interviews to answer two questions:

- What are the assumptions underpinning the GETS device? In other words, what are the models, scientific and technical knowledge, and modeling techniques that were used to design the GETS device? We used the interviews we held among the designers of the experiment – business people, economists and traders – to inform how they crafted the device: what their background, skills and interests were.
- How did the two experiments reframe the actors' representations, relations and strategies? Here we used our interviews with the actors of the experiment: participants, organizers and external stakeholders.

Figure 1 shows some examples of how we connected raw data to analytical categories and theoretical concepts based on Rerup and Feldman audit trail (2011).

----------Insert Figure 1 about here----------

Exploring low-carbon futures by designing *in vitro* carbon market devices

1997-1998: shaping the collective inquiry

In 1997, the Kyoto protocol set carbon emission targets for the Annex 1 countries, materialising the reality of a carbon constrained future. Anticipating a carbon constraint in the short run, the sector organised an inquiry into carbon market instruments: what would they look like and what type of world would they produce?

In 1997, some members of Eurelectric carried out an investigation on the SO_2 market that was in place in the US. They gained practical knowledge on emission trading from the

utilities that were part of the scheme. They also interacted with members of the EPA and discussed with them some of the theoretical features of the SO_2 scheme and lessons learnt.

In 1998, Eurelectric organised two colloquiums on carbon trading in Brussels and Austria, inviting both experts from the private sector and economists to present the principle of emission trading. In particular, Eurelectric invited Charlotte Grezo – who was in charge of the design of BP's internal trading scheme – and Richard Baron, an expert on the carbon economy from the International Energy Agency (IEA). After the colloquium, the members of Eurelectric's working group on climate change gathered and designed a generic model of a carbon market on a black board. "Jean-Yves [Caneill] who had visited the utilities in the US provided interesting insight taken from the SO_2 trading scheme, while Bill [Kyte] and I relied mostly on the input of Charlotte Grezo and Richard Baron" (Scowcroft, 2012).

At the beginning of 1999, Eurelectric invited the ParisBourse stock market and the International Energy Agency to organise a simulation exercise – a role play within the electricity sector – using the experimental carbon market they had designed. Eurelectric's generic model was refined together with the IEA. ParisBourse lent its trading platform during the empty hours to perform the simulation. The first device was reduced to a trading platform, a model generating uncertainty in electricity demand and a set of rules to frame the simulation. The IEA was charged with supervising the exercise.

----------Insert Figure 2 about here----------

As Richard Baron stressed, the GETS experiment was an exploratory exercise. "The organisers did not intend to determine precisely a projected price of carbon or the design of a carbon market for Europe" (Baron, 2010). What were these strange objects called carbon markets and what did they look like? What world did they offer and what future would they trigger: fields of wind turbines, restrictions on electricity consumption? What type of strategic activities and behaviours would they induce at company level: carbon trading, deployment of clean technologies, research on new technologies or enhanced management of the production capacity? What type of technical problems would they raise: was carbon trading compatible with electricity trading in a liberalised sector?

1999: Experimental carbon trading within the electricity sector

Nineteen power companies had agreed to participate in the role play. They were asked to create a virtual profile: they had to choose their energy mix and installed capacity. A total of sixteen virtual companies were created that had to comply with both national electricity demand and a carbon emission target (8% over emissions for the year 2000). To reach their objectives, they could choose from three options: electricity trading, carbon trading, or investing in clean technologies. The market place for electricity and CO_2 was the trading platform, provided by ParisBourse. "The simulation period lasted eight weeks, and covered the 2000-2012 time scale. Each week represented either one or two years of activity. Virtual companies could trade electricity and CO_2 once a week for two hours" (GETS1, 1999).

----------Insert Figure 3 about here----------

The results of GETS1: unveiling a carbon-constrained future

The future-oriented images provided by GETS1. The GETS1 (1999) report drafted by the IEA provides a wide range of images (charts, graphs, diagrams, tables etc.) that describe certain aspects of the future – from 2000 to 2012 – that would be driven by a carbon market. An important result of GETS1 was that "investment, not trading, delivers compliance at the end.[5]" It meant that under a carbon market, the energy structure in a future world might change radically. The results of the role play suggested that until 2012, the transition would mainly involve switching primary energy use from coal to gas.

----------Insert Figure 4 about here----------

Experiencing a carbon constrained future. The role play provided practical experience of this carbon constrained future by enabling the virtual companies to elaborate and test a wide range of compliance strategies. "Virtual companies were rapidly able to design decision-making tools" (Baron, 2011). The market device's ability to expediently deliver a carbon price signal was seen as crucial to the elaboration of a compliance strategy – i.e. clean tech investments vs. market strategies vs. plant management (GETS1, 1999: 1). Nevertheless, as it

[5] Speech by John Scowcroft in Vienna, July 2000.

was built under unrealistic assumptions, the experiment did not intend to anticipate future carbon prices.

Understanding carbon markets. The experiment generated knowledge on carbon markets and how they could drive a *low-carbon future*. To elaborate long-term strategies, virtual companies relied heavily on the possibility of banking[6] allowances from one commitment period to another. In a sector like the power sector, the size of investment in new production is largely dependent on the chosen technology: investing in a new 300 MW combined-cycle gas turbine may deliver more low-emission generation than what the company needs in order to comply with its CO2 objective. "Banking made it possible to benefit from these additional reductions, on top of the possibility to trade them immediately" (GETS1, 1999: 25). Virtual companies also relied heavily on the "grace period", that is to say the possibility of buying or selling permits after the end of the commitment period. Such a "grace period" helps "handle the uncertainty related to normal business operations", that may affect compliance (GETS1, 1999: p26). The role play highlighted for the first time one major outcome: as the emission objectives did not extend beyond 2012, companies had little or no incentive to build long-term strategies and developed uneconomic behaviours. This is called the "wall effect". Without long-term targets, the price of carbon falls to zero, which causes abnormal transactions, patterns and prices.

Preparing for the next step, strategy building towards a shared image of the future

[6]Banking means that the credits that are not used for compliance during a given period can be used for compliance in the following period.

From "carbon market reluctance" to "carbon market friendliness" in the power sector. Both Jean-Yves Caneill and John Scowcroft emphasised the role that GETS 1 played in reframing representations within the electricity sector. Before the role play, there was no consensus on carbon markets in the sector. Due to their energy mix, their economic culture and the national context in which they were evolving, companies held contrasting views regarding carbon markets. Companies in France and in the UK were in favour of carbon markets whereas German companies were reluctant. They were working on voluntary agreements with their government and a mandatory carbon market could jeopardise their efforts (Wettestad, 2005). Nevertheless, the experiment made it clear that a market was much more desirable than a tax if a mandatory regulation was to come up: "*the main learning point derived from GETS 1 was that a carbon market could help reduce compliance costs*" (Scowcroft, 2010). After the role play, companies envisioned carbon trading as a "tool for compliance" rather than a threat (GETS1, 1999: 25). The sector agreed that carbon markets had to be explored further and that they should be implemented as a tool for compliance at the European level. "*The only actors that were still reluctant after GETS1 were the German companies. Two German companies out of the three left the experiment during the second round*" (Scowcroft, 2012).

Building strategic alliances with the main stakeholders. "*Eurelectric presented the results of GETS1 at COP 5*[7] *in Bonn in 1999. The presentation was well received and helped nourish a*

[7] Fifth Meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change

constructive dialogue with the European Commission" (Caneill, 2010). In parallel, the Commission was working on a Green Paper on greenhouse gas emissions trading, which was likely to be the first step towards the implementation of a carbon market in Europe. The results of GETS 1 were used to draft a Position Paper on the Commission's Green Paper, in favour of carbon markets. Peter Vis, one of the civil servant of the Commission strongly engaged in the writing of the Green Paper, was keen to promote the constructive attitude of the power sector as it could become a key ally to implement the scheme. It was now of major importance to convince the rest of the industry that perceived the GETS experiment as a threat. They saw the experiment as a way for the electricity sector to secure strong positions that only they would benefit from. "*We were afraid that they could kill the process so we decided to involve them in another simulation. Had we not involved the rest of the industry, we might not have done GETS 2*" (Scowcroft, 2012).

2000. Re-making the device and evaluating competing futures

The second simulation aimed at unveiling and evaluating different possible carbon constrained worlds by testing different carbon market designs. To do so, the role play was re-organised and the GETS device was redesigned.

Re-organising the role play. Six new industrial sectors[8] - Iron and Steel; Refining; Chemicals; Glass; building materials and Paper – and the financial sector were invited to join

[8]All of the sectors discussed in the European Commission's Green Paper on greenhouse gas emissions trading.

the exercise. "Three successive simulations were run (GETS 2.1 in February/March, GETS 2.2 in April, and GETS 2.3 in June), thus making it possible to test and/or improve various assumptions" (GETS 2, 2000). A Steering Committee was created among the organisers to redesign the device, monitor the simulation and 'theorise the output'. "*We invited Peter Vis to join the steering committee. He didn't show up for every session but he did provide considerable input. His cooperation helped us to ensure consistency between the European Commission's view and the industrial view*" (Scowcroft, 2012). PriceWaterhouseCoopers was hired to develop the tools that would support the engineering of the GETS device.

Redesigning the device. To make the simulation more realistic and precise, the Steering Committee introduced some changes to the device: the platform allowed for trading electricity on both spot and future markets; variations in primary energy prices were introduced; participants could receive emission reduction credits through two types of project mechanisms[9]: the Clean Development Mechanism (CDM) and Demande Side Management (DSM) projects. Carbon targets were extended beyond 2012 to ease the wall effect. To ensure cooperation and involvement from the rest of the industry, newcomers were encouraged to make their own proposals regarding the design of the device. The experimental status of the GETS proved conducive to collectively proposing, debating and testing alternatives for the design of the carbon market device. The Italian industry proposed the implementation of a Demand-Side Management project which raised double counting issues. The nature of the

[9] These mechanisms enable Parties to achieve emission reductions or to remove carbon from the atmosphere cost-effectively in other countries.

experiment nevertheless made it possible to test, assess and ultimately collectively reject this alternative. The industry was mostly in favour of allocating quotas using a grandfathering approach: allocations based on historical emissions. But the cement sector was pushing for an allocation method based on a technological benchmark. On the European Commission side, Peter Vis advised to test an allocation method based on auctions. All three methods were tested within three different simulations. To meet the demand of the cement industry that was in favour of relative targets, and to test the ongoing developments in carbon markets in the UK, the steering committee proposed the implementation of a gateway that would enable the coexistence of both relative and absolute targets. None of the participants from the industry would take relative targets, so two electricity companies had to do so to test the gateway. "*The test showed that such a mechanism was very difficult to implement in practice, as the algorithm designed by PwC bugged and they had to cheat on the allocations to make it work*" (Scowcroft, 2012).

Designing a new relationship with time. Both the reorganisation of the simulation and the design of new instruments were driven by the reconstruction of carbon markets' way of relating to time. In GETS1 the wall effect highlighted the importance of clear long-term targets to take strategic action in the present. In GETS2, the timescale of the simulation was extended from 2012 to 2015. As future-oriented decisions were expected to improve liquidity in the present as well as encouraging the emergence of a market price, two financial institutions were invited (Holderbank and Natsource). The introduction of carbon credits in the second simulation from Kyoto's "Project Mechanisms" led to the superposition of two time scales: the

time of the market, that is, the present, and the time of the projects. The "time scale of Kyoto projects" varies from one project to another, depending on the type of project (medium-term in case of technology transfers, long-term in case of biological or geological sequestration of carbon). In the GETS, only three protocols were tested for CDM among the wide variety of existing methodologies. Furthermore, each of the three simulations of GETS2proposes an original relationship to time that opens onto a specific future. In GETS2.1, permits were distributed based on past emissions. In GETS2.2, permits were distributed according to a benchmark partly based on past emissions. In GETS2.3, permits were distributed partly based on past emissions and partly through permit auctions. In the first configuration, the future conditions are closely related to past tendencies: past emissions are the basis on which present action is taken. In the second configuration, future conditions are related to present conditions through the setting of a benchmark among the technologies available in the present. The setting of a particular benchmark is likely to have a considerable impact on future conditions as it drives technology development. In the third configuration, past conditions are no longer present. Future trends are directly anticipated by virtual companies that have to buy as much CO2 as they expect to produce during the compliance period. Thus, current decisions rely on forecasts of industrial production and energy efficiency.

Such reshuffling of the past, present and future conditions was supported by sophisticated instruments (creation of a gateway to enable the coexistence of benchmark credits and emission permits, design of new allocation protocols, design of new reporting

protocols, etc.) and rules (setting a protocol to organise auctions, negotiating technology benchmarks, etc.) that were designed by PriceWaterhouseCoopers (cf Figure 5).

----------Insert Figure 5 about here----------

Evaluating carbon constrained worlds. The report provides graphs and diagrams that display four aspects of these futures: (1) the level of carbon emissions; (2) the state of the carbon market; and (3) the effects of the model on company strategies (e.g. trading, fuel switching, recycling, process improvement, change in raw materials).

----------Insert Figure 6 about here----------

The effects of GETS2: performing carbon markets

Building a shared vision at the industry level. The second simulation had a similar learning impact as GETS1 on the scale of the industry: "*the role play provided the learning that was necessary to convince the industry as it helped defuse the negative connotations associated with it" (*Caneill, 2009). The experiments triggered an intellectual switch at the firm level: "*the experiment did convince my colleagues at Lafarge that were not familiar with the matter, in particular in the financial division*" (Boyd, 2011). In particular, the fact that the GETS device would quickly deliver a price signal proved crucial in shaping the collective expectation that a market device would deliver a "right" price of carbon rather than letting policy makers decide

what this price should be. The value of every proposition was assessed in this way by the market test. At the end of GETS2, the industry converged on the design of GETS2.1 that provided the simplest and cheapest way to undertake a *low carbon transition*.

Defending the GETS during the European Commission consultation process. The stakeholder consultation, organised by the European Commission, supported "*an intense process of collective sense making*" (Peter Zapfel, 2011). GETS is not the only experiment that fuelled the stakeholder meetings. Other schemes were "in competition". Many governments – such as the UK and Denmark – and industrial companies had developed their own original versions of carbon markets (Akhurst et al, 2003; Braun, 2009; Christiansen and Wettestad, 2003; Victor and House, 2006; Wettestad, 2005). According to Peter Zapfel, BP and the UK government were being particularly constructive and transparent in their contributions to the consultation. The UK put on the table an intricate architecture linking a climate-change levy with a carbon market. BP, which had introduced an internal scheme in 1998 to reduce its carbon intensity, also came up with a proposal. Nevertheless, BP's proposal was very specific to one company, and they ended up defending Eurelectric's proposal. The simplest proposal was that of Eurelectric's GETS2, which had already been tested and approved by the main industrial stakeholders. A year later, in December 2001, the Commission invited Eurelectric to present the results of GETS3 (a sensitivity study, based on implementation scenarios, following the first two experiments) at an official UNFCCC side event at COP 6 in Marrakesh, where the Commission officially presented its first EU ETS draft directive proposal.

Discussion: linking future imaginings to the present through Collective Engineering

Linking action in the present to learning on the future conditions

In the GETS case study, the performation work and the exploration of a low carbon future are undertaken jointly and inform one another. These two activities can continue through engineering on the GETS device. The organisers, participants and supervisors of the GETS were constantly taking decisions and assessing their effects on a hypothetical future by engineering the GETS device. The device operated as an epistemic machine that produced knowledge on both the present and the future, thus altering the actors' perceptions of reality (their interests, strategies, relations, relation to time, etc.). Hence, engineering on the GETS device participated in a low carbon transition as it helped to uncouple past tendencies from future conditions. The construction of the future does not follow a linear path. It is a chaotic process of exploration involving innovation through trial and error.

Performing carbon markets: the GETS device as a mediating instrument

To understand the strong role played by the GETS in performing carbon markets, we build on Miller and O'Leary's (2007) notion of a mediating instrument. First, the GETS device mediated between actors and domains that usually do not cooperate naturally with one another. Second, it organised the connection of different time scales, thus reshuffling the link between past, present and future conditions.

Mediation between actors and domains.

The GETS device provided a strong basis for coordination among the main stakeholders of the inquiry on carbon markets: the electricity sector, the industry, the European Commission, economists, iNGOs, etc. First, its collective design enabled the sharing of heterogeneous knowledge: economic theory; knowledge on technology development capacities; modelling; financial markets, etc. This knowledge was shared through the collective engineering of the GETS device and embedded in various details (tools, models, instruments, etc.). The role play provided the actors of the GETS experiment with shared knowledge and expectations regarding the carbon market. Second, the exploratory status of the GETS enabled cooperative relations that might have been difficult to obtain directly in the arena of stakeholder consultation. In particular, the interactions between the Commission and the organisers of the GETS help explain the similarities between the two designs. Thus, the GETS mediated between people and domains of knowledge that don't coexist easily. By enabling the management of knowledge about both carbon markets and a *low carbon future*, the GETS supported the constitution of an epistemic community (Amin and Cohendet, 2004).

Mediation between different temporalities

Engaging in a low-carbon transition involves a reshuffling of past, present and future conditions so the future is no longer the projection of past and present tendencies. The GETS experiment enabled different combinations of past, present and future conditions to be tested

through continuous engineering of the device. Each relationship to time was supported by sophisticated instrumentation. For example, from GETS1 to GETS2, this relationship was reconstructed by: (1) refining the device: long-term targets were introduced, trading was enabled on both spot and future markets, and carbon credits from Kyoto mechanisms were introduced; (2) reorganising practices on the device: two financial institutions – Holderbank and Natsource – were invited and the simulation was divided into three commitment periods instead of two; and (3) testing three different allocation configurations relating to three different combinations for the past, present and future conditions.

Mediating instruments as the core of experimental platforms. The GETS experiment was undertaken in a space that Muniesa and Callon (2007) call platforms. The platform configuration refers to a space that is more open than the laboratory and enables the participation of a great variety of actors that form an epistemic community. The GETS case study provides insights on these experimental platforms which have two main components: (1) a core that is a mediating instrument; and (2) an epistemic community that evolves with the engineering of the mediating instrument.

Conclusion

The GETS experiment did more than support the performation of carbon markets in Europe. It supported the collective sense-making that took place around carbon markets after

the Kyoto protocol. "*After Kyoto, carbon markets where rather unknown and curious objects that mostly belonged to the realm of academic fantasy*" (Zapfel, 2011). At the end of 2000, namely at the Hague Conference (COP 6), Eurelectric secured a slot from UNFCCC to present the GETS 2 results. "I remember the room – which was the largest side event room! – was full of people. The presentation of GETS 2 was attended as one of the most important side events of the Conference" (Caneill, 2010). This presentation by Eurelectric of the first carbon market pilots, in front of the international community, was the beginning of a huge international learning process on carbon markets. Furthermore, the materialisation of the EU-ETS was by far means not the end of the story. First, the EU-ETS has been – or rather is being – replicated in other countries that are building their own climate strategy. The performative effect of GETS might not be visible but it is embedded in the details of the emerging schemes that take the EU-ETS as a model. Second, the participants of the GETS are often asked to present their experience in other countries. Members of the utilities present the experiment to their counterparts as well as to the governments in other countries willing to develop an ETS. Building on GETS1, the IEA organised a region-wide simulation in the Balkan countries.

Organising a low-carbon transition is not only a matter of research, development and deployment of new technologies in engineering laboratories to uncouple growth and carbon emissions; it is also a matter of uncoupling the future conditions from the past conditions when setting frameworks for action. The framework for action in Europe lies in the details of the EU-ETS design that reshuffles the link between the past present and future conditions. Experiments like the GETS are central in testing different configurations for action frameworks.

The GETS device served to compare and test the connections between the past, present and future conditions. The reason why there are only few traces of this experiment in the literature might be because the construction of knowledge is, by nature collective: concepts and images are produced, they circulate, and they perform reality. The GETS output are invisible, they circulate in forms of concepts, images among the discussions on carbon trading, and they frame the response to climate change more and more as carbon markets are being replicated.

References

Aggeri F (1999) Environmental policies and innovation: A knowledge-based perspective on cooperative approaches. *Research Policy* 28: 699–717.

Aggeri F and Labatut J (2010) La gestion au prisme de ses instruments : Une analyse généalogique des approches théoriques fondées sur les instruments de gestion. *Finance Contrôle Strategie* 13(3) : 5-37.

Amin and Cohendet (2004) *Architectures of knowledge: Firms, Capabilities, and Communities. USA:* Oxford University Press.

Amoore L (2009) **Algorithmic War: Everyday Geographies of the War on Terror**. *Antipode* 41: 49–69.

Anderson B (2010) Preemption, precaution, preparedness : Anticipatory action and future geographies. *Progress in human Geography* 34(6):777-798.

Anderson B (2007) Hope for nanotechnology: anticipatory knowledge and the governance of affect. *Area* 39(2): 156-165

Akhurst M, Morgheim J and Lewis R (2003) Greenhouse gas emissions trading in BP.*Energy Policy*31(7): 657–663.

Berry M (1983) Une technologie invisible : L'impact des instruments de gestion sur l'évolution des systèmes humains. *Cahiers de recherche du CRG*

Braun M (2009) The evolution of emissions trading in the European Union: The role of policy networks, knowledge and policy entrepreneurs. *Accounting, Organizations and Society,* 34: 469–487.

Borup M, Brown N, Konrad K and Van Lente H (2006) The Sociology of Expectations in Science and Technology. *Technology Analysis & Strategic Management* 18(3-4) 285–298.

Brown N, Rappert B and Webster A (2000) *Contested Futures: A Sociology of Prospective Techno-Science*. Aldershot: Ashgate.

Callon M (1998) Introduction : the embeddedness of economic markets in economics. in Michel Callon (Ed) *The laws of the markets*. Oxford, Blackwell: 1-57.

Callon M (2009) Civilizing markets: Carbon trading between in vitro and in vivo experiments. *Accounting, Organizations and Society* 34: 535-548.

Coase R (1960) The problem of social cost. *Journal of Law and Economics* 3: 1–44.

Christiansen C and Wettestad J (2003) The EU as a frontrunner on greenhouse gas emissions trading: How did it happen and will it succeed? *Climate Policy* 3 (1): 3–18.

Convery FJ (2009) Origins and development of the EU-ETS. *Environmental and Resource Economics* 43(3): 391-412.

Crocker TD (1966) The structuring of atmospheric pollution control systems. In: Wolozin H (ed.) *The Economics of Air Pollution*. New York: W.W. Norton.

Dales JH (1968) *Pollution, property and prices*. Toronto: University Press.

Damro C and Luaces-Mendez P (2003) Emissions trading at Kyoto: from EU resistance to Union innovation. *Environmental Politics* 12(2): 71-94.

De Goede M and Randalls S (2009) Precaution preemption: arts and technologies of the actionable future. *Environment and Planning D: Society and Space* 27: 859-878.

Eames M, McDowall W, Hodson M and Marvin S (2006) Negotiating contested visions and place-specific expectations of the hydrogen economy. *Technology Analysis & Strategic Management* 18(3-4): 361-374.

Eisenhardt KM and Graebner ME (2007) Theory building from cases: opportunities and challenges. *Academy of Management Journal* 50(1): 25-32.

Ellerman D, Convery FJ and De Perthuis C (2010) *Pricing carbon: The European Union Emissions Trading Scheme*. Cambridge: Cambridge University Press.

GETS1 (1999) Greenhouse gas and electricity trading simulation.This report has been drafted by Baron R, IEA and Cremades R, ParisBourseSBF SA in collaboration with the UNIPEDE/*EURELECTRIC* Working Group on Climate Change.

GETS 2 (2000)Greenhouse gas and electricity trading simulation 2.This report has been drafted by Kieken H, Marty A and ThieryC under the supervision of Laurent Segalen - PricewaterhouseCoopers (PwC), in collaboration with the Gets2 Steering Committee.

Godard O (2004) Le casse-tête de l'effet de serre au crible du développement durable. *Cahiers de l'école polytechnique* 10 : 1-15.

Guala F (2005) *The Methodology of Experimental Economics.* Cambridge: Cambridge University Press.

Guala F (2007) How to do things with experimental economics? In: McKenzie D, Muniesa F and L Siu (eds.), *Do economists make markets? On the performativity of economics.*

Guice J (1999) Designing the future: The culture of new trends in science and technology. *Research Policy* 28: 81–98

Hacking I (1983) *Representing and intervening : introductory topics in the philosophy of natural science*. Cambridge: Cambridge University Press.

Hatchuel A (1994) Apprentissages collectifs et activités de conception. *Revue Française de Gestion* juin-juillet : 109-120.

Hatchuel A (1998) Comment penser l´action collective : Théorie des mythes rationnels. In: Damien R, andTosel R (eds) L´action collective : coordination, conseil, planification. Anales littéraires de l´université de Besançon, vol 653.

Hatchuel A and Weil B (1995) *Experts in Organizations: A knowledge based perspective on organizational change*. New York: Walter de Gruyter.

Hatchuel A, Le Masson P and Weil B (2005) The development of science-based products: Managing by design spaces. *Creativity and Innovation Management* 14(4): 345-354.

Hepburn C ,Grubb M, Neuhoff K, Matthes F, and Tse M (2006) Auctioning of EU ETS phase II allowances: How and why? *Climate Policy* 6(1): 137–160.

Hjerpe M and Linnér BO 2009. Utopian and dystopian thought in climate change science and policy. *Futures* 41(4) : 234-245.

Hourcade JC (2002) Dans le labyrinthe de verre: la négociation sur l'effet de serre. *Critique international* 2(15) : 143-159.

Hulme M (2008) The conquering of climate: discourses of fear and their dissolution. *The geographical journal 174* (1):5-16.

IPCC (2007) Climate Change 2007: Impacts, Adaptation and Vulnerability. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ and Hanson CE (eds) *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press, pp779-810.

Labatut J, Aggeri A, Girard N (2012) Discipline and change: How technologies and organizational routines interact in new practice creation. *Organization Studies* 33 (1) 39-69.

Latour B (1987) *Science in Action: How to Follow Scientists and Engineers through Society.* Open University Press: Philadelphie.

Liverman DM (2009) Conventions of climate change: construction of danger and the dispossession of the atmosphere. *Journal of historical geography* 35:279-296.

Lohmann L (2009) Toward a different debate in environmental accounting: The cases of carbon and cost-benefit. *Accounting, Organizations and Society* 34 (3-4) : 499–534.

MacKenzie D (2003) An Equation and its Worlds Bricolage, Exemplars, Disunity and Performativity in Financial Economics. *Social Studies of Science* 33 (6) : 831-868.

MacKenzie D (2004) The big, bad wolf and the rational market : Portfolio insurance, the 1987 crash and the performativity of economics. *Economy and Society* 33(3): 303-334.

MacKenzie D (2006) *An engine, not a camera : How financial models shape markets*, Cambridge: MIT Press.

MacKenzie D (2007) Is economics performative? Option theory and the construction of derivative markets. In: McKenzie D, Muniesa Fand L Siu (eds.), *Do economists make markets? On the performativity of economics.*

MacKenzie D (2009) Making things the same: Gases, emission rights and the politics of carbon markets. *Accounting, Organizations and Society*34: 440–455.

MacKenzie D and Millo Y (2003) Constructing a market, performing theory : The historical sociology of a financial derivatives exchange *American Journal of Sociology* 109(1): 107-145.

Michael M(2000) Futures of the present: from performativity to prehension. In: Brown N, Rappert B, and Webster A (eds) *Contested Futures: A Sociology of Prospective Techno-Science.* Aldershot: Ashgate.

Miller P and O'Leary T(2007) Mediating instruments and making markets: Capital budgeting, science and the economy.*Accounting, Organizations and Society* 32 (7-8): 701-734.

Moisdon JC (1997) Du mode d'existence des outils de gestion. France : SeliArslan.

Moisdon JC (2005) Comment apprend-on par les outils de gestion ? Retour sur une doctrine d'usage. In :Teulier R and Lorino P (eds.)*Entre connaissance et organisation : l'activité collective*. France : La Découverte, pp. 239-250.

Montgomery WD (1972) Markets in licenses and efficient pollution control programs. *Journal of Economic Theory* 5: 395-418.

MuniesaF and Callon M (2007) Economic experiments and the construction of markets. In: McKenzie D, Muniesa Fand L Siu (eds.), *Do economists make markets? On the performativity of economics.* Princeton: Princeton University Press, pp. 163-189.

Muniesa F and Callon M (2008) La performativité des sciences économiques. *CSI Working Papers Series* 10: 1-23.

Nellemann C, Verma R and Hislop L (2011) Women at the frontline of climate change, gender risks and hopes, a rapid response assessment. *United Nations Environment Programme*. GRID-Arenal.

Newell P and Paterson M (1998) A Climate for Business: Global Warming, the State and Capital. *Review of International Political Economy* 5(4): 679-703.

Nierlich B (2012) Low carbon metals, markets and metaphors: The creation of economic expectations about climate change mitigation. *Climate Change* 110:31-51.

Nyberg D and Wright A (2011) Prevention, pre-emption and preparedness: Corporate responses to climate change as a logic of risk. In: *Ashridge International Research Conference,* **Berkhamsted**, UK, 10-12 June 2011, pp1-26.

Pettigrew AM (1990) Longitudinal field research on change: Theory and practice. *Organization Science* 1(3): 267-292.

Pinder D (2005) *Visions of the city : Utopianism, power and politics in twentieth century urbanism.* Edinburgh: Edinburgh University Press.

Rerup C and Feldman MS (2011) Routines as a source of change in organizational schema: the role of trial-and-error learning. *Academy of Management Journal* 54: 577-610.

Skjaerseth JB and Wettestad J (2008) Implementing EU Emissions Trading: Success or Failure? *International Environmental Agreements* 8 (3): 275-290.

Segrestin B (2006) Innovation et coopération interentreprises. Comment gérer les partenariats d'exploration? CNRS Editions, Paris, 175p.

Tietenberg TH (2006) *Emissions Trading: Principles and Practice.* Washington DC: Resources for the future.

Van Aalst MK (2006) The impacts of climate change on the risk of natural disasters. *Disasters* 30(1) p5-18.

Van Lente H (1993) Promising technology: the dynamics of expectations in technological development.PhD Thesis, University of Twente, NL.

Victor D and House J(2006) BP's emissions trading system. *Energy Policy* 34: 2100–2112.

Wettestad J (2005) The making of the 2003 EU emissions trading directive: An ultra-quick process due to entrepreneurial proficiency*? Global Environmental Politics* 5(1): 1-23.

Zapfel P and Vaino M (2002)Pathways to European greenhouse gas emissions trading history and misconceptions. Fondazione Eni Enrico Mattei, nota di lavoro.

Tables and figures

Table 1. GETS2 vs EU-ETS pilot

	GETS 2.1 (2000)	**EU-ETS Pilote (2003)**
Market Type	Cap and trade	Cap and trade
Target	Absolute	Absolute
Asset	1 permit = 1tCO2eq	1 permit = 1tCO2eq
Constraint	Up-stream	Up-stream
Coverage	6 Kyoto Gases	CO2
Procedure		
Allocation mode Permits restitution	Grandfatherng End of each commitment Period	Grandfatherng End of each commitment Period
Opt-in Opt-out	No	No
Flexibility		
Carbon price mechanisms		
Ceiling price	No	No
Threshold price	No	No
Credits		
CDM1&2, JI	Yes, 30% limit	Yes, variable limit
DSM	No	No
Temporal Flexibility		
Banking	Yes	Yes
Borrowing	No	No
Monitoring		
Penalties	Yes, non discharging	Yes, non discharging

Figure 1. Data Analysis

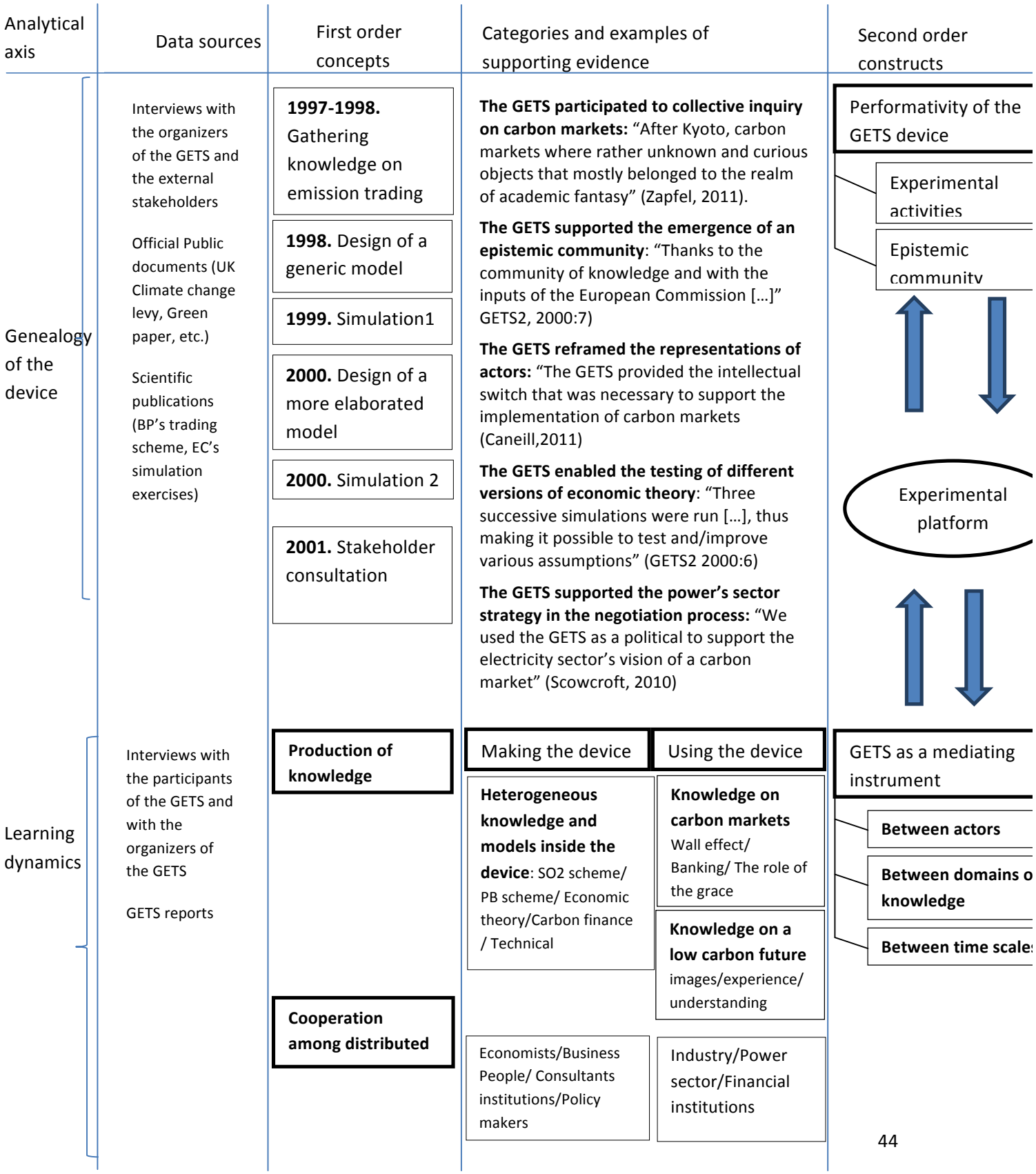


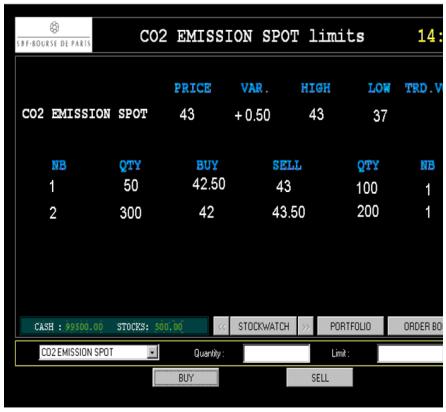
Figure 2. The GETS device

Rules of the Games

Gets 1	
Market type	Cap and trade
Commodity	1 quota = 1tCO2eq
Constraint	Up-stream
Scope	6 Kyoto Gases
Procédure	
Allocation	Grandfathering
Permits restitution	At the end of each commitment period
Opt-in Opt-out	No
Flexibilité	
Carbon price mechanisms	
Ceiling price	No
Threshold price	No
Credits	
CDM1&2, JI	**S.O.**
DSM	**S.O.**
Temporal Flexibility	
Banking	Yes
Borrowing	No
Surveillance	
Pénalités	Non discharging

Management of the simulation

Trading platform



Models: Electricity demand
Clean Technologies Investments

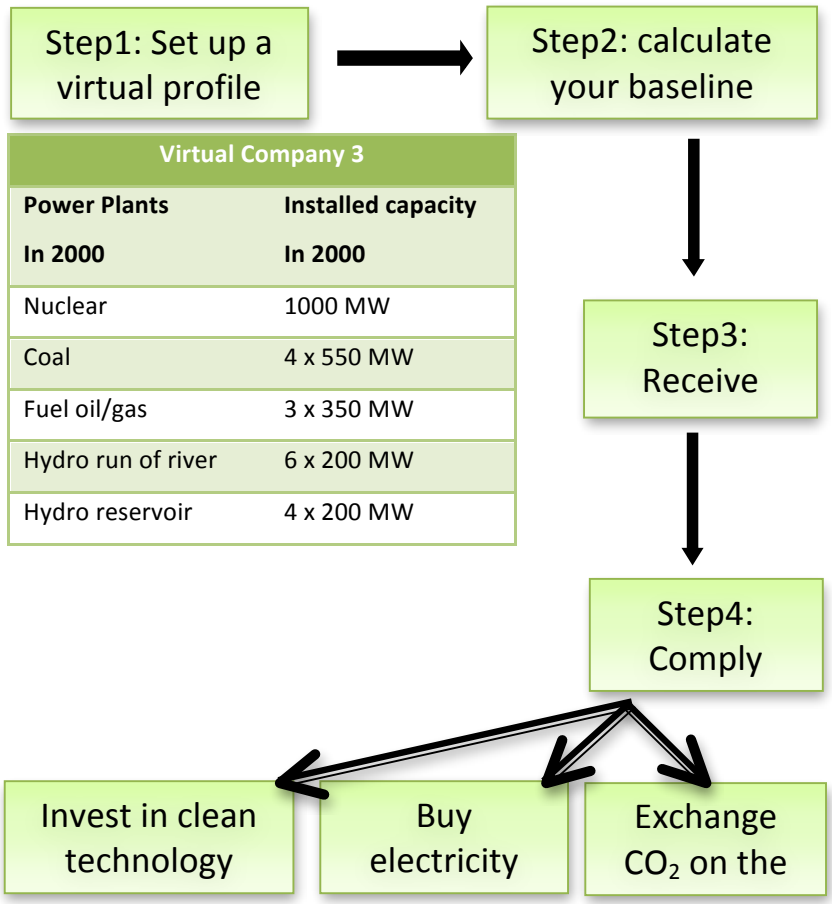
Actors

Participants = Utilities

Master of the Game: IEA

Organizers of the Game: Eurelectric

Figure 3. The role play



Virtual Company 3	
Power Plants In 2000	**Installed capacity In 2000**
Nuclear	1000 MW
Coal	4 x 550 MW
Fuel oil/gas	3 x 350 MW
Hydro run of river	6 x 200 MW
Hydro reservoir	4 x 200 MW

Figure 4. Changes in installed capacities 2001-2012 in GETS1 report, 1999

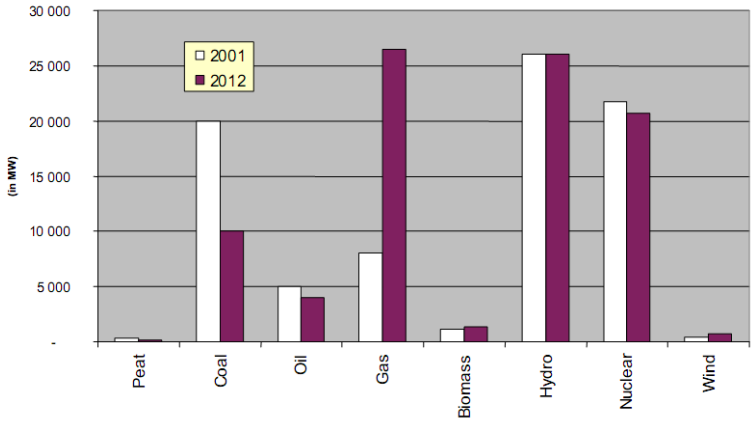


Table 2. From GETS1 to GETS2: remaking the device

	GET1	GETS2	Asked by	Tools/Models/ Instruments	Designed/Provided by
		Revising the basic frame on the outputs of GETS1			
Electricity trading	On spot	On spot and future market	The steering Committee	Internet trading & Clearing platform	Paris stock exchange
Primary energy prices	Constant	Yearly changes in gas and fuel prices	The steering Committee	Algorithm governing annual changes in prices	PwC
Targets	Until 2012	Until 2015	The steering Committee	Designing a new target	The Steering Committee
		Collective engineering of the device			
Allocation	Grandfathering	Grandfathering	The industry	Setting a baseline	The steering Committee
		Benchmarking	The Cement sector	Negotiation of a benchmark	The virtual Companies
		Auctioning	The European Commission	Auction Protocol	PwC
Targets	Absolute targets	Both relative and absolute targets	The British Utilities	Gateway	PwC
		CDM	The industry	3 protocols	PwC
Offset trading	No	DSM	The Italian utilities	4 protocols	PwC
		Management of the simulation			
Reporting				Reporting protocol	PwC
				Reporting tool	PwC
				Monitoring system	PwC
Information		Exchanges among participants		Forum	PwC
		Real time information system		Real time information system	PwC

Figure 5. The second GETS device

Rules of the Game	GETS 2.2	**Asspciated Tools**
Market Type	Cap and trade Absolute + Index based emissions	α = 1 - |Σ negative EPCs|/Σ positive EPCs
Asset	1 permit = 1tCO2eq	
Constraint	Up-stream	
Coverage	6 Kyoto Gases	
Procedure		
Allocation mode	Benchmarking	X % x Grandfathering + (1 - X %) x Emission Objectives
Flexibility		
Ceiling price	No	
Threshold price	No	
CDM1&2, JI	Yes, 30% limit	3 protocoles
Demand side management	Yes, 30% limit	I = F + p x E x D / 100
Banking	Yes	
Borrowing	No	

Actors	
Participants	Utilities + 6 Industrial sectors + 2 financial institutions
Organizers	Eurelectric
Manager	PwC
Steering Committee	PwC + Eurelectric + Paris Stock Exchange + informal participaion of the EC

Management of the simulation

Reporting system

Trading platform

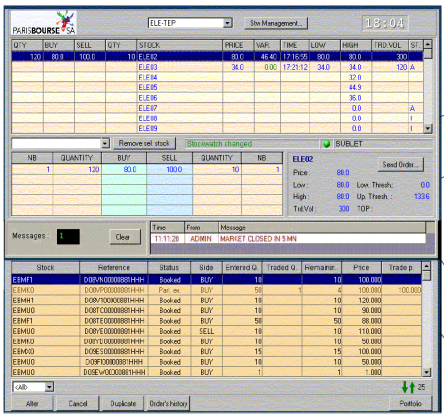
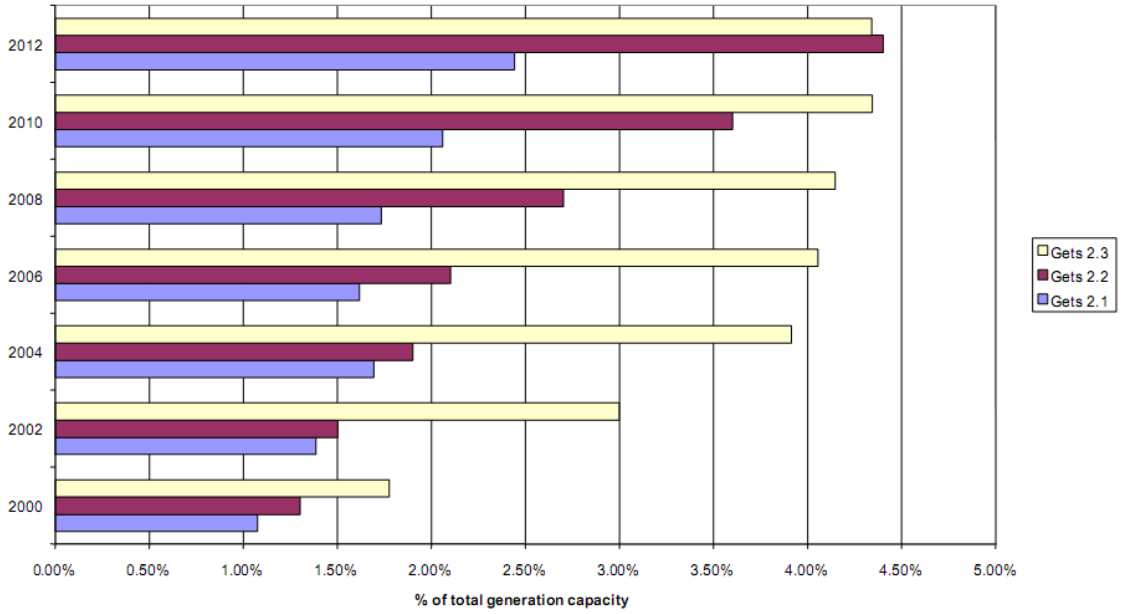


Figure 6. Share of new renewables in the total installed generation capacity in GETS2. in GETS2 report, 2000. p43



List of interviews

1. Jean-Yves Caneill, Head of Climate Policy at Electricité de France, December 2009
2. Philippe Quirion, Research fellow, CNRS, March 2010
3. Jean-Yves Caneill, Head of Climate Policy at Electricité de France, March 2010
4. Thierry Carol, ParisBourse, May 2010
5. Jean-Yves Caneill, Head of Climate Policy at Electricité de France, August 2010
6. John Scowcroft, Head of Environment and Sustainable Development at Eurelectric October 2010

7. Dirk Forister, Natsource, November 2010
8. Richard Baron, Head of climate policy, International Energy Agency, November 2010
9. Vincent Mage, Head of Climate Change Initiatives at Lafarge, April 2011
10. Richard Baron, Head of climate policy, International Energy Agency, April 2011
11. Jean-Yves Caneill, Head of Climate Policy at Electricité de France, May 2011
12. Richard Armand, former General Secretary, Entreprise pour l'Environnement
13. Peter Zapfel, Climate Change Unit in the European Commission's DG Environment, November 2011
14. Chris Boyd, Founding member of the CSI (1999-2003), November 2011
15. Marco Mensink, Deputy Director General at Confederation of European Paper Industries, December 2011
16. Bernard de Galembert, Forest and research director at Confederation of European Paper Industries, December 2011
17. Bruno Vanderborght, Vice-President Climate Change at Holcim, January 2011
18. John Scowcroft, Head of Environment and Sustainable Development at Eurelectric. May, 2012.